Numb. 132.

PHILOSOPHICAL TRANSACTIONS.

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A Continuation of Mr. Boyle's *Experiments, publiſhed in the next foregoing Tract, about Fluids contiguous to other Fluids. An Account of two Books:* I. *PALÆOLOGIA CHRONICA, &c. by* Robert Cary, *D.L.L.* II. *A TOUCH-STONE for Gold and Silver-Wares, &c. by* W.B. *of* London *Goldſmith.*

A Continuation of Mr. Boyle's *Experiments publiſhed in the laſt Tranſactions; for which there was no room there.*

IN the Winter time, and at other times alſo when the Air is cold enough, the figure, acquir'd by the ſurface of an Oil contiguous to the Water on one ſide, and the Air on the other, may be preſerved from varying, and ſo may be at leiſure obſerved by the Direction afforded by the following Experiment, which I deviſed for this purpoſe.

In Cold weather we took Eſſential Oil of *Anniſeeds*, whoſe property it is to coagulate in ſuch weather, and having in a gentle warmth brought it to be fluid, we poured it into a ſlender Viol more than half filled with Common water, that had been alſo a little warmed, that the Oil might not be too haſtily reduced to its former ſtate. This Oil being lighter than ſo much Water, and being poured on in a convenient quantity, had its upper ſurface ſomewhat concave, as that of the Water was; but the lower ſurface, ſurrounded by the Water, was very convex, appearing almoſt (for it was not perfectly) of the figure of a great Portion of a Sphere. This being done, the Viol was ſtopt, and ſuffered to reſt for ſome time in a cold place, by which means the Water continuing fluid as before, the *Oil of Anniſeeds* was, as I expected, found coagulated in a form approaching to that it had whilſt in a fluid ſtate; I ſay, approaching, becauſe it was not eaſie to diſcern the exact Exp. XIV

Figure in the Viol I was fain to make uſe of: and I ſuſpected, that the Oil grown conſiſtent was become leſs convex than before; but the two *ſurfaces* of it gave it ſome reſemblance in point of ſhape, but not of tranſparency, to a *Concavo-Convex Glaſs*; but yet much thicker in the middle than is uſual in Glaſſes of the like breadth, employed for *Dioptrical Purpoſes*. And indeed (to give here this Advertiſement once for all) I would not have you underſtand in too ſtrict a ſenſe, what my intended brevity, and ſome other Motives, make me deliver in naming the Figures of *Fluids*. For I confeſs, that if I were to write for a rigid *Geometrician*, eſpecially if he were nice and critical in the Doctrine of *Conic Sections*, I ſhould think my ſelf obliged on ſome occaſions to a greater Curioſity in naming the Figures of *Fluids*, than you will meet with in this Paper: But ſince I write but Notes, and deſign to give you rather Experimental hints, than *Geometrical* Determinations, I preſume, that when you are once cautioned by a plain Advertiſement, it may ſuffice for me to refer the *Fluids*, I deſcribe, to ſuch of the more known *Figures* as they ſeemed to be the leaſt remote from, without troubling you or my ſelf with maim'd Figures, or with *Spheroids, Conoids, Paraboloids*, and other hard words; which I the rather abſtain from, not only becauſe the Particulars, wherein my *Fluids* reſembled them and differ'd from them, could not be intelligibly declared without many words; but becauſe I obſerved the *Figures* themſelves of the *Fluids* to vary, and ſometimes conſiderably too, according to Contingent circumſtances. And for this Reaſon alſo I will not perſwade you to expect, that the event of every Trial, you ſhall make of theſe Experiments, will be preciſely the ſame with the event of mine. For by reaſon of thoſe contingent Circumſtances, I dare only ſpeak Hiſtorically of theſe Experiments, and, without pretending that they ſhall always uniformly ſucceed, content my ſelf to relate *bonâ fide*, what Trials have been made, and what happen'd to me thereupon, not deſpairing, that this variation it ſelf of Events according to Circumſtances may be Inſtructive.

But to return to our lately mentioned *Oil of Anniſeeds*, 'twas worth obſerving, how great a difference there was between the dull reflection it made when 'twas coagulated, and the fine reflection it had made whilſt 'twas a Liquor. The later of which

Reflections

Reflections brought into my mind, how vivid the reflective power of ſome *Fluids* is in compariſon of that of the generality of Solid bodies, of which there is ſcarce any, if there be any at all, that is obſerved to have a ſtronger Reflection than clean *Quickſilver* ; and yet (to add that upon Exp.XV. the by) I have ſometimes found, that this it ſelf may be increaſed by the addition of a Liquor. For having obſerv'd, as I elſewhere note, that *Quickſilver*, and Rectified *Oleum Petræ* are, the former of them the heavieſt, and the later the lighteſt of all the viſible *Fluids* that are yet known to us, or at leaſt to me; and having alſo obſerved the later of them to be conſiderably reflective, I had the Curioſity to try among other things, that related to them, the following Experiment. Some (Diſtill'd) *Quickſilver* being put into a ſmall Viol, and held in ſuch a poſture, that the incident Light was ſtrongly remitted to my Eye, I ſlowly put to it ſome *Petroleum*, that being well rectified was very clear, and obſerved, that, as this Liquor cover'd the *Quickſilver*, there was at the Imaginary Plain, where they both confined, a brisker Reflection than the *Quickſilver* alone had given before; whether this increaſe of Reflective power proceeded from any thing produced upon the confines of the two Bodies, or from ſome *Ethereal fluid* that ſlip'd in there, I have above declined, and ſhall now forbear, to examine: But on this occaſion it will not be amiſs to take notice, that either the ſurface of the Air it ſelf, as thin and yielding a *Fluid* as it is, or the ſurface of a Solid, contiguous to included Air, or ſome interpoſed ſubtile matter, may reflect the Incident beams of Light more ſtrongly than moſt men would expect. To this purpoſe I remember, that a Curious Perſon having one day brought me a couple of Rarities, which he told me were two pieces of a ſolid, but tranſparent, body, that he had caſually found; in one of which there was a *Pearl*, large, round, and orient, and in the other a leſs perfect one; and having deſired my Opinion, whether they were conſiderable enough to be preſented to the King: I, after I had ſufficiently view'd them in differing Poſitions, and eſpecially againſt the Light, aſked him, whether he were ſure the included bodies were *Pearls*. To which when he anſwer'd, that his Eyes permitted him not to doubt of it, eſpecially becauſe he knew of no other Gems nor Stones, that had ſo ſtrong and fine a Reflection; I replied, that I thought they might be only bubbles of Air, caſually intercepted in the viſcous matter of the containing Bodies, (which I ſuppoſed,upon good grounds,to have been once ſomewhat *fluid*,) before it came to be hard ; adding, that His *Majeſty*, who was Critical in theſe matters,might probably have the Curioſity, I had , to have the worſt of them broken, to be ſatisfied what kind of bodies the included were. Hereupon, to content me , one of them was open'd , and that which had appear'd a *Pearl* was found to be but a Cavity , that contain'd no groſſer ſubſtance than Air. And I have by me a well ſhap'd piece of *Glaſs* of a good thickneſs, with an *Aereal bubble* in the middle, which by ſome qualities, particularly its *Pear*-like ſhape and vivid reflection, does not ill reſemble a fair, though not *Orient*, *Pearl*. But in ſuch like Obſervations, the Poſition of the Eye,and that wherein the Body receives the beams of Light, may be very conſiderable. For I have by me a ſmall Stone (with which I have puzled the Skilful *Jeweller* of a great Prince to determine what kind of *Gem* it is) that being laid flat upon ones hand, or a piece of Paper, and lookt on directly downwards, looks almoſt like a piece of common *Glaſs*, and is tranſparent : But if the Eye be ſo placed , that the Incident beams of Light, by whoſe Reflection 'tis ſeen, fall with a convenient degree of obliquity upon the Stone , it makes an exceeding pretty ſhew, ſometimes appearing like a fine *Opal*, and ſometimes not very unlike an *Orient Pearl*.

Exp.XVI. It may not be altogether impertinent , and at leaſt, for the Novelty of the way of Trial, it will not probably be unpleaſing,if I here mention an Attempt to try,whether, when the Rays of light rebound from bubbles inviron'd with an uniform Solid body (which caſe is ſomewhat differing from that of Bubbles look'd upon in an exhauſted *Receiver*,) the Reflection be only,or almoſt only, from the groſſer Particles of the Air, and not alſo from ſome Subtile matter harbour'd,as well as they, in the ſame Cavities ? But to bring this queſtion to Trial,ſeemed difficult enough, becauſe it is ſo, to include very rarified Air in a conſiſtent body, *diaphanous* enough to let its reflection be eaſily obſerved. To compaſs this, I thought upon the following Expedient. We made, according to the eaſie direction * elſewhere given, (for other purpoſes,) a competent quantity of a *Reſinous* or *Gummous* ſubſtance, that looked like high colour'd

Amber,

* *In the uſef. of Experiment. Philoſophy.*

Amber, but was eaſie to melt. This we put into a deep round Glaſs with a wide mouth, and held it by the fire-ſide in a moderate warmth, till it was brought into a *fluid* ſtate ; then we transfer'd it into one of our *Pneumatical Receivers*, where we preſum'd, that this Temporary Liquor would, as well as Liquors that are conſtantly ſuch, diſcloſe *Aereal bubbles*, when the preſſure of the Air was withdrawn from it ; and accordingly having cauſed the *Air* to be pumpt out by degrees, we found, that ſtore of Bubbles appear'd at the top of the Liquor, and made there a copious Froth , many of them being, by reaſon of the *viſcoſity* of the Fluid, very large, and divers of them, becauſe of the Nature and Texture of it and the Thinneſs of the films, being adorn'd with the colours of the *Rainbow*, whoſe vividneſs made them pleaſant to behold, and ſuggeſted to Us ſome *Optical* Conſiderations. But notwithſtanding this Froth, I cauſed the pumping to be continued, that thoſe Bubbles that had moſt of common Air in them, and which therefore are wont to riſe firſt, might get to the top , and the ſubſequent Bubbles might meet with more reſiſtance from the Liquor ſtill tending to grow cold, and ſo might be the more expanded , and yet kept from emerging by the concretion of the *Reſinous* ſubſtance ; and anſwerably to this we found, that, when this Subſtance had reſumed its conſiſtent form, there were intercepted, between the upper and the lower *ſurfaces* of it, ſome Bubbles that were not ſmall, which yet had a conſiderable Reflection, notwithſtanding the ſmall quantity of the groſſer Particles of the Air, that may be ſuppoſed to be contained in Bubbles ſo very much expanded, (perhaps ſo, as to exceed ſome hundreds of times their former Dimenſions.) I might add, that by letting the outward Air into the *Receiver*, the Air in divers of the formerly mention'd large Bubbles, at the top of the Glaſs, was too much rarified to keep them from being broken by the preſſure of the returning Air. But I am ſenſible, that, in what I have ſaid of the Reflective power of the Air, I have already too far digreſſed, and therefore I ſhall ſtep into the way again , and proceed to other Obſervations.

Water being ſo conſiderable a Body here below, I thought, it would be worth while, to endeavour to obſerve its *Surface*, when contiguous to other Fluids than *Air*, and, if it were poſſible, when ſurrounded by them. For though 'tis Exp.XVII.

'tis taken for granted, that the falling drops of *Rain* are ſpherical, yet their deſcent is ſo ſwift, both by reaſon of their Gravity in reſpect of the Air, and the height from whence they fall, that I fear men have rather ſuppoſed than obſerved that their figure is Spherical; which will be the more queſtionable, if it be true, which is vulgarly thought, that *Hail* is but *Rain* frozen in its paſſage through the Air. For 'tis evident, that the grains of *Hail* are frequently of other figures than truly orbicular. But becauſe there may another poſſible Account be given of this Irregular Figuration of *Hail*, I ſhall not inſiſt on this *Phænomenon*, but proceed to what I tried about the *Surface of Water*; of which I found it the more difficult to make Obſervations, becauſe that Liquor will readily mingle both with *Spirit of Wine* and with *Oil of Tartar*, and with other Liquors that are analogous to either of theſe.

The *Surface of Water* may have differing Figures, according as 'tis totally incompaſſed with *heterogeneous fluids*, or, as 'tis only in ſome places contiguous to one or more of them. In the former caſe we found it not ſo eaſie to make an Obſervation, both becauſe, that, as I lately noted, we know not of any two Liquors (ſetting *Mercury* aſide) that will not mingle either with one another, or with *water*. And becauſe alſo our *Oil of Guajacum* it ſelf, though heavier than *Water*, would not be ſerviceable on this occaſion, in regard of its being of ſo deep a Red, that the figure of the Water incloſed in it could not be diſcerned through it; wherefore I made uſe of Chymical *Oil of Cloves*, as being ſomewhat, and but a little, heavier in *Specie* than Water, ſo that ſome drops or ſmaller portions of this laſt nam'd Liquor would be almoſt quite inviron'd with the other: We cautiouſly therefore conveyed into ſome *Oil of Cloves*, whoſe *ſurface* the Veſſel permitted to be large enough, ſome portions of *common Water* of differing bigneſſes, taking care, as far as we could, that they might not touch one another; by which means the Oil being tranſparent, and yet ſomewhat colour'd, 'twas eaſie to obſerve, that the ſmaller portions of Water were ſo near totally inviron'd with the Oil, that they were reduc'd into almoſt perfect globes; thoſe portions, that were ſomewhat bigger, (as about twice the bigneſs of a *Pea*,) would be of a figure ſomewhat approaching to that of an *Ellipſis* (for 'twas not the

Exp. XVIII.

ſame)

ſame,) and thoſe portions that were yet ſomewhat larger, though they ſeem'd to be ſunk almoſt totally beneath the Oil, yet they held to it by a ſmall portion of themſelves, whoſe *ſurface* was eaſily enough diſtinguiſhable from that of the Oil. Theſe larger portions of immers'd Water, being almoſt wholly inviron'd with the other Liquor, were by it reduc'd into a round figure, which was ordinarily ſomewhat *Elliptical*, but more depreſs'd in the middle than that figure requires. But all this is to be underſtood of thoſe portions of Water, that touched only the Oil and the Air: for thoſe that touched one another without mingling, and much more thoſe that adher'd more or leſs to the ſides of the Glaſs, had their *ſurfaces* too differingly and irregularly figur'd to be here attempted to be deſcribed.

As for the *Superficial figure of Water*, contiguous, both above and beneath, to other *Fluids*, and laterally to ſome Solid body, 'tis not ſo eaſie to be ſure, which of the contiguous Liquors is of moſt force to determine the figuration of their common *ſuperficies* or *Commiſſure*. But however I ſhall relate, that, having into a ſlender Pipe of that ſort that has been deſcrib'd before, put a little *Oil of Cloves*, and upon this ſome *Oil of Turpentine*, that ſo the Water might both above and beneath be touched by *heterogeneous Liquors*, I obſerv'd not the *Oil of Cloves* to be very manifeſtly tumid at the top, nor the lower ſurface of the *Oil of Turpentine* (for the upper was Concave) to be very Convex; for ſomewhat *convex* it was, downwards. And from this 'twill be eaſie to conclude, the *figure* of the Cylindrical portion of Water intercepted between theſe two Oils. Exp. XIX.

That Agent or force, whatever it be, that keeps Liquors *fluid*, does likewiſe, whilſt they are ſo, keep their *ſurfaces* exceeding ſmooth, when they are contiguous to the Air and other Fluids. But becauſe I thought it doubtful, whether even thoſe Liquors that are (as Men uſually ſpeak) *naturally* fluid, I mean, ſuch as are not made ſo by fuſion, produced in them by the action of the Fire, would retain ſmooth ſurfaces when they have loſt their *fluidity*, and have their parts no longer inflected and agitated, ſo as to enable them, by the help of *Gravity*, *Viſcoſity*, or both, to *levigate* (if I may ſo ſpeak,) or poliſh each others ſurfaces, as it may be gheſs'd in their fluid ſtate they did;

I thought it not amiſs, in order to the clearing of the doubt, to make ſome Trials with *contiguous Liquors*, whereof one would continue fluid when the other had loſt its fluidity.

Exp. XX.

I took then *Oil of Anniſeeds*, thaw'd by a gentle warmth, aud *common Water*, and having put them together in a conveniently ſhaped Glaſs, they were ſuffer'd to ſtand in a cold place till the Oil was coagulated; which done, it was parted from the Water, and by the roughneſs of its *ſuperficies* manifeſted, as I expected, that, when its parts were no longer agitated and kept eaſily diſplaceable by the ſubtile *permeating* matter, or whatever other Agent or Cauſe it were, to which it ow'd its Fluidity, then the contiguous Water grew unable to inflect, or otherwiſe place them after the manner requiſite to conſtitute a *ſmooth ſurface*. And what happen'd to that part of the Oils ſurface that was touch'd by the Water, happen'd alſo to that which was contiguous to the Air; ſave that the *aſperity* of the laſt nam'd ſurface was differing from the other, which, whether 'twere an accidental or conſtant *Phænomenon*, further Trial muſt determine. But I have often obſerved, that the upper ſurface of *Oil of Anniſeeds*, when this Liquor comes to be coagulated by the cold Air, was far enough from being ſmooth, being variouſly aſperated by many flaky particles, ſome of which lay with their broad, and others with their edg'd, parts upwards.

Exp. XXI.

An *inequality* and *ruggedneſs* of *ſuperficies* I have alſo obſerv'd in Water, when, having cover'd it with Chymical *Oil of Juniper*, and expos'd it in very Cold weather, though the Oil continued fluid, yet the Water, being frozen, had no longer a ſmooth *ſuperficies*, as whilſt in its liquid ſtate 'twas contiguous to the Oil. And the like Inequality, or rather a greater, we obſerved in the ſurface of Water frozen, which had Chymical *Oil of Turpentine* ſwimming over it; yet a no leſs, if not a much greater, roughneſs may be oftentimes obſerved in the ſurfaces of divers Liquors that abound with Water, when thoſe Liquors being frozen, their *ſurfaces* have an immediate contact with the Air. This I, among others, (elſewhere) obſerved; And I ſhall here add, that having purpoſely cauſed a ſtrong and blood-red decoction of the *Soot of Wood* to be expoſed in a large Glaſs in a very Cold night, I was more pleaſed than ſurpriz'd, to find in the morning a Cake of

Ice, that was curiouſly figur'd, being full of large flakes ſhap'd almoſt like the broad blades of Daggers, but neatly fringed at the edges. But that which I chiefly mention theſe Figures for, is, that they ſeem to be as it were imboſt, being both to the Eye and the Touch rais'd above the Horizontal plain or level of the other *Ice*.

Exp.XXII.

And here I muſt not omit to take notice, that whereas in the recited Experiments the rugged ſurface was produced at the Confines of two *heterogeneous* and unſociable Liquors, I have ſometimes obſerved the like *Phænomenon* in one and the ſame Liquor, and particularly, not long ſince looking in Froſty weather on a Viol where I had long kept *Oil of Vitriol*, I perceived, that the Cold had reduced far the greateſt part of the *Menſtruum* into a conſiſtent Maſs, whoſe upper ſurface was very rugged and odly figured, though it lay cover'd all over with a pretty deal of high colour'd Liquor, that was not frozen or coagulated, nor ſeem'd diſpoſed to be ſo, at leaſt in that degree of Cold.

Exp.XXIII.

This brings into my mind, that not only Bodies, which in their Natural ſtate (as 'tis wont to be call'd) are *fluid*; but alſo ſuch, as, by the violence of the fire, are made to flow, may be conformable to ſome naturally Fluid bodies in their ſuperficial Figures. This may be obſerv'd in the beſt ſort of what the Chymiſts call *Regulus Martis ſtellatus*, where the figure of a Star, or a figure ſomewhat like that of the *Decoction of Soot* lately mention'd, will frequently appear imboſt upon the upper *ſuperficies* of the *Regulus*; and ſuch a rais'd Figure I think I can yet ſhew you, on a Maſs of *Regulus* made of *Antimony* without *Mars*. But if, to thoſe two bodies, *Copper* be alſo skilfully added, the *Superficies* will be oftentimes adorned with new Figures according to Circumſtances; though the moſt uſual I took notice of was that of a Net, that ſeem'd to cover the ſurface of the compounded *Regulus*. But this is not ſo conſtant, but that I have by me a Maſs of a *Conical figure*, conſiſting of two very contiguous, but eaſily ſeparable, parts, whereof the lowermoſt, which abounds more in Metal, hath its upper ſurface cover'd with round *protuberances*, in ſhape and bigneſs not unlike to ſmall *Peaſe* cut in two; and theſe are ſo really imboſt and elevated above the reſt of the *ſuperficies*, that the other part of the Cone, which is of a more ſcorious Nature, has, in its lower ſurface, which exactly fits the upper of the *Regulus*, Cavities, for number, ſhape and bigneſs, anſwering to the *protuberances* lately mention'd; which argues, that the *Regulus* cooled firſt with that Inequality of ſurface we have deſcrib'd, and that the lighter and more Recrementitious ſubſtance, continuing longer fluid, had thereby opportunity to accommodate it ſelf to the ſuperficial Figure of the *Regulus*, on which it firſt lean'd, and was afterwards coagulated.

So far of this Sequel at the preſent; what remains may be expected at the firſt conveniency.

An Account of two Books:

I. *PALÆOLOGIA CHRONICA: A Chronological Account of Ancient time: In Three parts; Didactical, Apodeictical, Chronical. By* Robert Cary, *D.LL. Devon.* London, 1677, *in fol.*

THe Deſign of this elaborate Work ſeems to be, to determine the juſt interval of Time between the great *Epocha* of the *Creation of the World*, and that other of the *Deſtruction of Jeruſalem* by *Titus Veſpaſian*, in order to the aſſignment of ſuch particular *Time*, wherein Perſons and Actions of old had their Exiſtence. For the performance of which, the Learned Author divides this his Book into *three* main parts.

In the *firſt* he treats not only of his Meaſure in general, which is the *Year*, and its parts; but alſo of the *Julian Year* in particular, by him eſteem'd the fitteſt for his Uſe: conſidering it both in it ſelf, and in relation to other the moſt received kinds, for the reducing of them to this. Where comes-in the *Julian Period*, of which he diſcourſes very fully; ſhewing *firſt*, How it is made up, *viz.* by the Multiplication of the Cycles of the *Sun*, *Moon*, and Indiction into one another, as 28 into 19, and the product thereof into 15, which produces 7980, the *Julian Period*, ſo called, becauſe accommodated to the *Julian Year*; the ground whereof was taken from the Ancient *Greek* Church, perfected and promoted in this later Age by *Joſ. Scaliger*'s dexterity. *Secondly*, What the contrivance is of this